Necker Island, Hawai'i: Astronomical Implications of an Island Located on the Tropic of Cancer

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STRETCHING OUT BEYOND THE MAJOR ISLANDS of Hawai'i all the way to Midway and the Kure Atoll lie the Northwestern Hawaiian Islands made up of a number of rocky islets, reefs and atolls. One must travel some 240 kilometers west-northwest of Kaua'i before coming to the first island in this Hawaiian chain, little Nihoa, and then it is another 280 km on to the next, even smaller island, Necker (Figure 1). According to the *Atlas of Hawaii*, the area of the larger of the two, Nihoa, is 77.2 hectares (190 acres) or just over three-quarters of a square kilometer. (For comparison, Easter Island measures 17,700 hectares.) Nihoa's maximum elevation is 277 meters. Even smaller Necker measures 23.6 hectares (58 acres) and reaches only 84 meters above sea level. Both are included in the Hawaiian Islands National Wildlife Refuge established by President Theodore Roosevelt in 1909 and now are under the management of the Fish and Wildlife Service of the U.S. Department of the Interior. Both are fully closed to the public. The *Atlas of Hawaii* states that "...only the relatively inaccessible island of Nihoa retains much of its endemic biota in spite of extensive terracing by ancient Polynesian settlers." Nihoa, an Hawaiian word meaning "jagged", is a fitting name for the island, while the name Necker presumably comes from the name of the ship or the crew member who first sighted it.

When Captain Cook discovered the major Hawaiian Islands in 1778, he had no knowledge of the existence of the Northwestern Hawaiian Islands. After Cook and several of his men were killed on the island of Hawaii early in 1779, western ships avoided the islands for several years, but by 1785, they had become way stations in the developing commerce between Asia and the Americas. Like most of the outlying islands, Necker and Nihoa were discovered accidentally by merchantmen trading between Canton and the Pacific Northwest.

The *Atlas of Hawaii* goes on to say that "...a Tahitian-like culture, isolated from the rest of Hawaii, once existed on Nihoa and Necker". Kenneth Emory, who investigated the two islands in 1924, pointed out that the ancient religious structures that he found there resembled more closely the religious temples of Tahiti than the corresponding structures on the main Hawaiian Islands (Emory 1928). It would seem, therefore, that Tahitians – or possibly Marquesans—first landed on these islands perhaps a thousand years ago unaware of the existence of the larger islands to the south.

Besides the undisturbed terracing recorded on Nihoa, two rectangularly shaped, contiguous *marae* on Nihoa were discovered there by Emory (1928), both oriented "approximately north-south". It should be noted that he chose to use the word

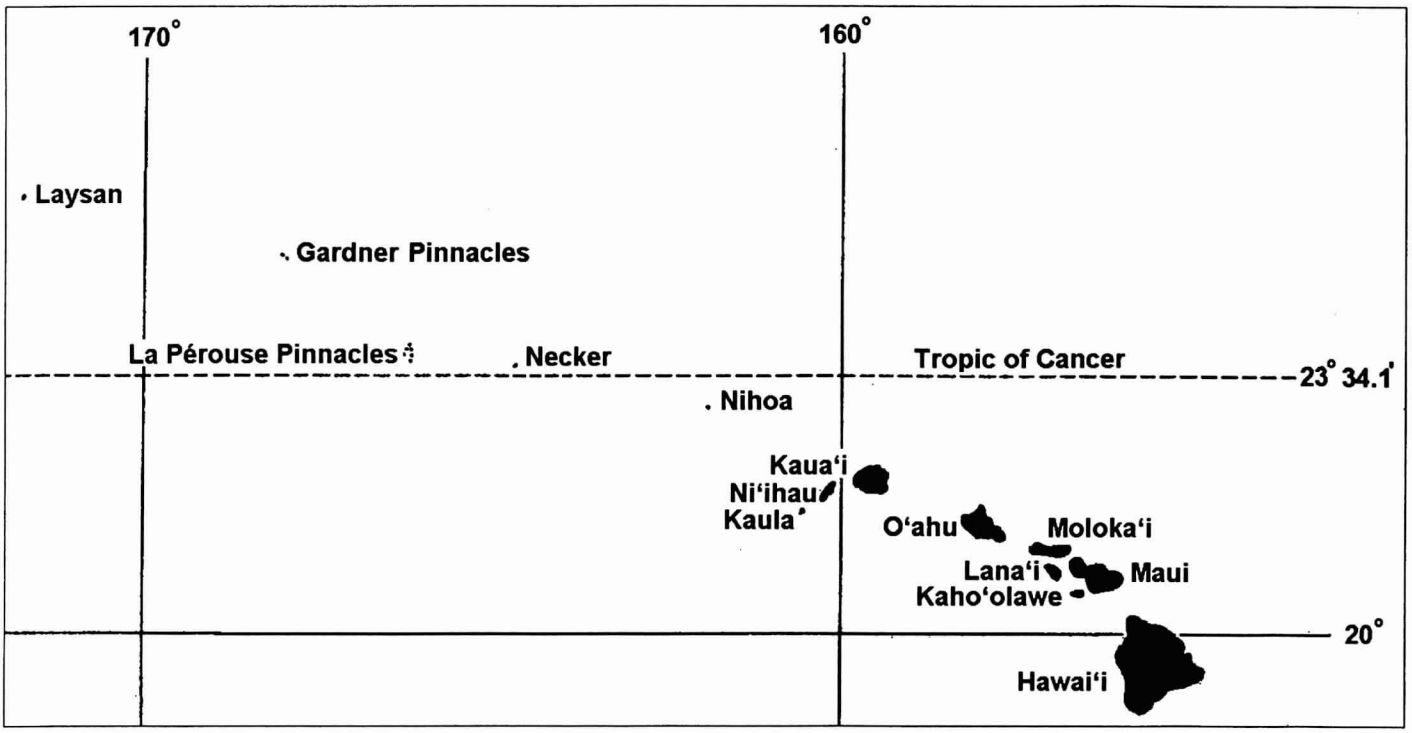

Figure 1. Map showing the location of Nihoa and Necker with respect to the well-known Hawaiian Islands and the Tropic of Cancer located in latitude as it is at the present time. About 1000 years ago the tropic passed directly over Necker.

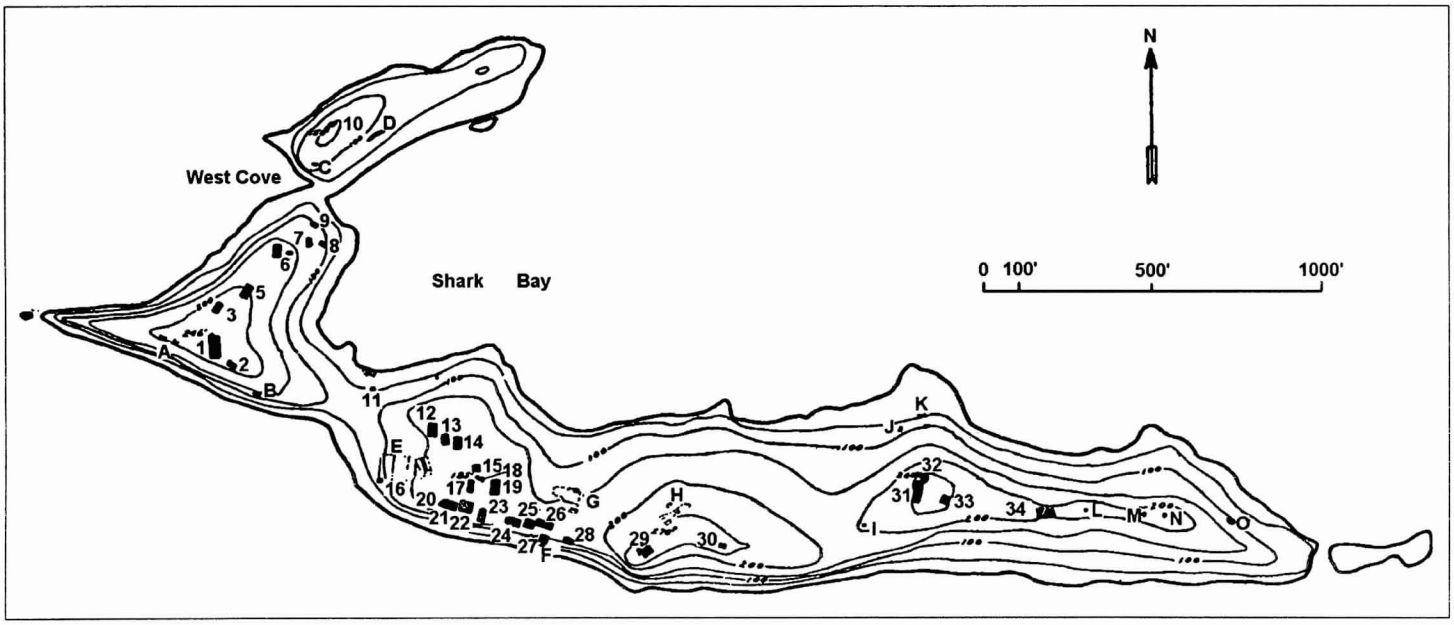

Figure 2. Map of Necker Island showing position of archaeological sites: 1-34, sites of religious structures; A-O, sites of other structures. (from Emory, Archaeology of Nihoa and Necker Islands, Bernice P. Bishop Museum Bulletin 53).

"marae" rather than "heiau", the word used by native Hawaiians for the shrines found on the main islands. After Emory surveyed Nihoa, he turned his attention to Necker and was surprised to find that despite the island's much smaller area, there were an astonishingly large number of marae: 34. In his report, he shows plans for all but two of these. Almost all are shown as rectangles—only one has a rounded side—and most are situated well back from the shore or the island cliffs. Emory comments that all but five of the marae are comprised of "...a long, narrow, rectangular platform which faces on a paved rectangular terrace. Along the full length of the rear of the platform an odd number of upright slabs which average 2.5 feet in height ... are set at equal intervals." (Emory 1928).

Why is it that such a large number of marae are crowded on to tiny Necker and only two on the larger Nihoa? When one considers Emory's map of the island (Figure 2), one quickly notes that many of the marae lie almost parallel to one another. Emory carefully indicated their orientations and remarked that "Lt. Brown of the Coast and Geodetic Survey checked and corrected the plans". Demonstrating these orientations objectively, Figure 3 presents a histogram of the orientations of the 32 marae; here the number of marae in each 5 degree interval ("bin") of azimuth are shown. The azimuth measurements are of the back side—the side next to the row of uprights on the platform. Thus, for example, the marae indicated by the vertical bar at 0 degrees, No. 18, is aligned almost north-south. In the figure the letters J, E, and D indicate the azimuths of the rising sun at the June solstice, the equinoxes, and the December solstice, respectively. As can be seen, the marae show two preferred orientations: the first is east-west (azimuth 90 degrees), and the other with alignments very nearly matching that of the rising winter solstice sun. Because the island is dominated by a ridge that lies roughly in an east-west direction orientation, it is easy to understand why four marae are oriented near azimuth 90 degrees. But finding 9 of the 32 marae aligned with the rising winter solstice (and the setting summer solstice) strongly suggests that these orientations were no accident: the ancient Polynesians must have had a reason, practical or ritual, for constructing these solstitially aligned marae. Furthermore, they may well have taken advantage of the east-west ridge to build marae aligned with the rising (and setting) equinoctial sun.

Why, then, were there so many astronomically oriented

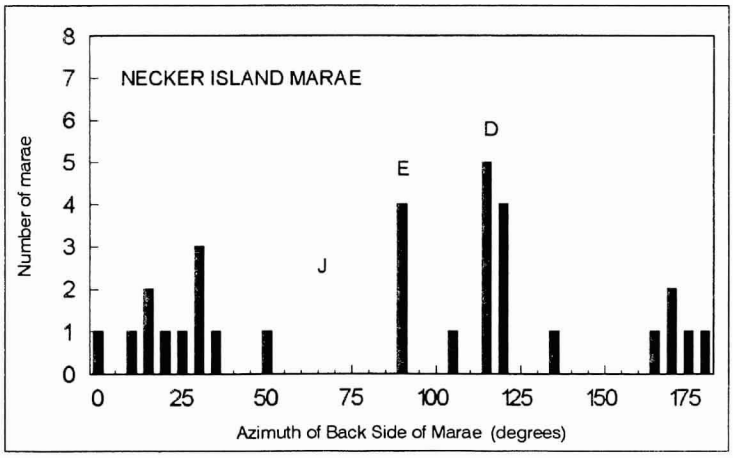

Figure 3. The distribution in orientation (measuring from the back side) of the Necker Island marae.

marae on Necker? No where else in the Hawaiian Islands can be found this many marae constructed with these special orientations (Liller 2000; see also Liller 1991). The answer may well be because Necker Island has a unique latitude: the island center is located at latitude 23° 34.5'N meaning that in the year AD 1000, it was almost exactly at the latitude of the Tropic of Cancer, namely 23° 34.1'N. (According to the Astronomical Almanac published annually and jointly by the U.S. Naval and the

Royal Greenwich Observatories, the latitude of the Tropic of Cancer changes slowly, decreasing by about 1' every 128 years.) This means that on the day of the summer solstice, June 21 according to our modern calendar, the day that the sun reaches its most northerly point, the sun passed directly overhead as seen from Necker. Nihoa, farther south by a half degree, was not so well favored, but could the difference of that half degree—55 kilometers—have been significant to the ancient Polynesians? Quite possibly.

Would the early inhabitants of Necker have realized that the sun was directly overhead on what we call June 21st? On that day when the sun was highest in the sky, a vertical stick would have cast no shadow, and on all other days of the year at high noon, with the sun father south in the sky, this same stick would have cast its shadow to the north. On Nihoa a vertical stick standing 57 inches tall would have cast a half-inch long shadow southward on June 21st. Twelve days before and again 12 days after June 21, no shadow would have been seen as the sun passed overhead. A similar situation would have occurred on all the main islands of Hawaii south of the Tropic of Cancer: solar zenith passage would have taken place twice a year.

Why might have a location on the Tropic of Cancer been so important to the early inhabitants? From a strictly calendric point of view, knowing that the sun was directly overhead and on only one day of the year—on the first day of what we call summer –was a simple and precise way of noting the passage of a year. But surely there must have been profound mythological and ritualistic reasons. To give one example, an Hawaiian myth related by Chauvin (2000) "...claims that when the sun passes through Hawaii's zenith...and the bodies become 'shadowless', the strength of the sun passes into its worshipper, and the time is called *ka la i la lolo* (the hour of triumph, or, literally, the sun on the brain)." Perhaps this concept arrived with the voyagers who came from Tahiti or the Marquesas.

No other Polynesian islands are located close to the Tropic of Cancer, but in the southern hemisphere, there are several islands near the corresponding Tropic of Capricorn. In the Australs, Tubua'i was located only 23 km north of this circle of latitude in AD 1000, and four other islands including Ra'ivavae were within 350 km. Vérin (1969) reported six marae on Tubua'i, and he says that four show alignment with the December solstice sunset. According to Edwards (1992), the probability of this happening totally by chance is about one in 7,700, but he also notes that the marae are near a coastline which has "the same solstice direction". In the same publication Edwards reported that he had recorded 92 marae on Ra'ivavae, and of the 79 that he was able to measure, 11 (14 %) are astronomically oriented. No where in the Society Islands to the north are so many marae found that are so oriented. Again we have evidence for unusual astronomical activity on an island situated near a Tropic latitude.

A thousand years ago Pitcairn was approximately 120 km south of the Tropic of Capricorn, while the neighboring islands of Henderson and Ducie are even closer. However, none of the scant remains of ancient civilizations found on these islands give us any clues.

As for civilizations in other parts of the world, Broda (2000) has written that "At the Tropic of Cancer...the summer solstice coincided with the zenith passage [of the sun]. There, the sun 'turns around' or 'stands still' on its apparent journey to the north and back again to the south. Ancient Mesoamericans were aware of this solar phenomenon at least since the Classic period [AD 200-900], because they built an important site at Alta Vista (latitude 23° 28.8' N), in the modern state of Zacatecas". A detailed study of this site had been made by Aveni, Hartung and Kelley (1982), and they concluded that observations of the solstices and the equinoxes were made at this "sun temple". They further noted that Alta Vista was a distant outpost, some 400 km north of the great sacred center at Teotihuacan. Broda states that for this reason, "Alta Vista...is one of the most enigmatic and appealing archaeological sites of Mexico."

There are of course many other lands located at these special Tropic latitudes – in Africa, the Middle East, India, China, Australia and South America. Perhaps other sites exist whose primary purpose was to make note of the noontime passage of the sun on the day it arrived at the solstice. They should be researched. Meanwhile, I should think that since it has been 76 years since Emory visited Necker, a new more exhaustive archaeological study should be made of this fascinating little island that was once perched on the Tropic of Cancer.

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